

WE CLAIM:

1. A collection of particles wherein the particles comprise zinc and at least one non-zinc metal, the non-zinc metal having a reduction potential equal to or more positive than the reduction potential of the zinc, wherein the particles have an average diameter from about 0.1
5 mm to about 1 mm.
2. The collection of particles of claim 1 wherein the at least one non-zinc metal is present in a concentration of from about 50 parts per million to about 10,000 parts per million.
- 10 3. The collection of particles of claim 1 wherein the at least one non-zinc metal is present in a concentration from about 200 parts per million to about 800 parts per million.
4. The collection of particles of claim 1 wherein the particles have an average diameter from about 0.3 mm to about 0.7 mm.
- 15 5. The collection of particles of claim 1 wherein the particles have a size distribution wherein at least 95 percent of the particles have a diameter greater than about 40 percent of the average diameter and less than about 160 percent of the average diameter.
- 20 6. The collection of particles of claim 1 wherein the particles have a particle density of at least 5 g cm^{-3} .
7. The collection of particles of claim 1 wherein the at least one non-zinc metal is selected from the group consisting of bismuth, indium, tin, lead, thallium, mercury,
25 magnesium, manganese, aluminum and combinations thereof.
8. The collection of particles of claim 1 wherein at least about 95 percent of the particles have lengths along the three principle axes of the particles that are within a factor of three of the average particles diameter.

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9. A fuel cell fuel comprising a collection of particles of claim 1 dispersed in an aqueous alkaline electrolyte.

10. A fuel cell fuel of claim 9 comprising from about 30 weight percent to about 50
5 weight percent KOH.

11. A fuel cell fuel of claim 9 further comprising a stabilizer selected from the group consisting of a silicate salt, lithium hydroxide, sorbatol, sodium metaborate and combinations thereof.

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12. An electrochemical cell comprising:

an anode comprising a collection of metal particles of claim 1 and an electrolyte in a flowable dispersion;

a gas diffusion electrode comprising a catalyst for catalyzing the reduction of a
15 gaseous oxidizing agent; and

a separator between the anode and the gas diffusion electrode.

13. A fuel cell system comprising an electrochemical cell of claim 12 and a regeneration unit connected to the electrical chemical cell wherein the regeneration unit is operably
20 connected to the electrochemical cell to provide the electrochemical cell with a regenerated collection of particles.

14. A regeneration solution for use in a electrochemical cell, the solution comprising:

an alkaline aqueous electrolyte;

25 zincate ions; and

at least one non-zinc metal oxide or metal hydroxide.

15. The regeneration solution of claim 14 further comprising a zincate stabilizer.

16. The regeneration solution of claim 15 wherein the zincate stabilizer is selected from the group consisting of a silicate salt, lithium hydroxide, sorbatol, sodium metaborate and combinations thereof.
- 5 17. The regeneration solution of claim 15 wherein the stabilizer comprises sodium silicate.
18. The regeneration solution of claim 14 further comprising zinc particles.
19. The regeneration solution of claim 14 wherein the zincate ions are present in a
10 concentration from about 0.3M to about 5.2M.
20. The regeneration solution of claim 14 wherein the at least one non-zinc metal oxide or metal hydroxide is present in a concentration from about 100 ppm by weight to about 500 ppm by weight.
- 15 21. The regeneration solution of claim 14 wherein the at least one non-zinc metal oxide or metal hydroxide is present in a concentration from about 50 ppm by weight to about 1000 ppm by weight.
- 20 22. The regeneration solution of claim 14 wherein the at least one non-zinc metal oxide is selected from the group consisting of the oxides of mercury, indium, bismuth, tin, lead, thallium and combinations thereof.
23. The regeneration solution of claim 14 wherein the sodium silicate is present in a
25 concentration from about 1 percent by weight to about 5 percent by weight.
24. The regeneration solution of claim 14 further comprising poly(vinyl pyrrolidone) at a concentration from about 500 ppm to about 1000 ppm.
- 30 25. The regeneration solution of claim 14 wherein the electrolyte comprises potassium hydroxide at a concentration from about 30 weight percent to about 50 weight percent.

26. A regeneration unit comprising the regeneration solution of claim 14, an anode and a cathode suitable for regenerating metal particles.

27. The regeneration unit of claim 26 further comprising a pump for circulating a
5 regeneration solution through the regeneration unit.

28. The regeneration unit of claim 26 further comprising a storage container for storing a portion of the regenerated collection of metal particles.

10 29. A method of replenishing the fuel for a metal-based fuel cell comprising an anode and a cathode, the method comprising:

providing a collection of particles of claim 14 dispersed in an electrolyte to the anode of the fuel cell.

15 30. The method of claim 29 wherein the collection of particles is generated in a regeneration unit comprising two electrodes.

31. The method of claim 29 wherein the collection of particles has a size distribution wherein at least 95 percent of the particles have a diameter greater than about 40 percent of
20 the average diameter and less than about 160 percent of the average diameter.

32. A method for electrolytically generating zinc particles from a solution comprising oxidized zinc, the method comprising:

generating zinc particles from a regeneration solution by applying a sufficient voltage
25 to the regeneration solution such that oxidized zinc is reduced to zinc particles, wherein the regeneration solution comprises an electrolyte, oxidized zinc, and at least one non-zinc metal oxide.

33. The method of claim 32 wherein the generated zinc particles have an average particle
30 diameter from about 0.1 mm to about 1 mm.

34. The method of claim 32 wherein the regeneration solution further comprises sodium silicate.

35. The method of claim 32 wherein the voltage is applied to the regeneration solution in a
5 regeneration unit using oppositely charged plates.

36. The method of claim 35 wherein the oppositely charged plates are aligned parallel to each other in the regeneration unit.

10 37. The method of claim 32 wherein the regeneration solution is continuously circulated through the regeneration unit by a pump.

38. The method of claim 32 wherein the regeneration solution is periodically circulated through the regeneration unit by a pump.

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39. The method of claim 32 wherein at least a portion of the generated zinc particles are transported from the regeneration unit to a storage container.

40. The method of claim 32 wherein the generated zinc particles have a size distribution
20 wherein at least 95 percent of the particles have a diameter greater than about percent of the average diameter and less than about 160 percent of the average diameter.

41. The method of claim 32 wherein the regeneration solution is generated in a metal/air
fuel cell by the oxidation of a collection of particles comprising zinc and at least one non-zinc
25 metal.

42. The method of claim 32 wherein the generated zinc particles are consumed in a metal/air fuel cell to form a consumed zinc solution.

43. The method of claim 42 wherein a sufficient voltage can be applied to the consumed zinc solution to generate a collection of zinc particles, wherein the collection of zinc particles has an average particle diameter from about 0.1 mm to about 1 mm.